

Armijo, Kenneth
Higa, Adrienne
Lawrence, Kyle
Zeledón, Esther

Seguro Pesticide Protection Group - Final Report

Context and Background

Currently pesticides are used extensively in agribusiness; the commercial method of crop production in the Central Valley. These pesticides are designed to kill insects and thus are inherently poisonous. According to the California Department of Pesticide Regulation (DPR),¹ it is estimated that in 2003, 175 million pounds of pesticides were applied in California; 60 million of which were sprayed in the three Central Valley counties of Tulare, Kern, and Fresno. Consequently, pesticides pose the largest hazard to human health, especially to farm-workers and their families. They have been found by the CDC to cause long term health problems in addition to acute toxic effects. California State Data has shown that between the years of 1991 to 1996 there were 4,000 reported instances of farm-worker poisoning.² As a result, chemical pesticide exposure among migrant-farm-workers within California's Central Valley has become a topic of much concern over the past two decades.

Social

Pesticide exposure can happen via two main pathways: primary and secondary routes. Primary exposure occurs when farm-workers contact pesticides on their bodies and clothing while working in the fields. Pesticides are absorbed through the skin, eyes, lungs, mouth, and are ingested from harvested produce.^{3,4} Secondary exposure occurs off the field when pesticides are transported to other parts of the community through the contamination of farm-workers' homes and cars. Farm-workers transport pesticides into their cars and homes with the residues that are left on their clothing after work. This problem is furthered when they return home making contact with loved ones. It is hypothesized that wearing long sleeves shirts and removing one's clothing before entering domestic settings can significantly decrease primary and secondary exposure.

Farmworkers are exposed to harsh working conditions, including extreme weather conditions with few resources (e.g. sanitary facilities). Farming companies' often neglect workers' needs and health issues; this is especially true when the majority of the workers are immigrants. Normally, after pesticides are applied to a field, workers are not permitted to enter the field until a clear date has passed. However, many times workers are permitted inside the field before time. From subsequently mentioned surveys they know they are being poisoned but they refrain from complaining in fear they may be fired. On the consumer end, there is little information into farm-worker conditions and the effects of pesticide applications.

Historical

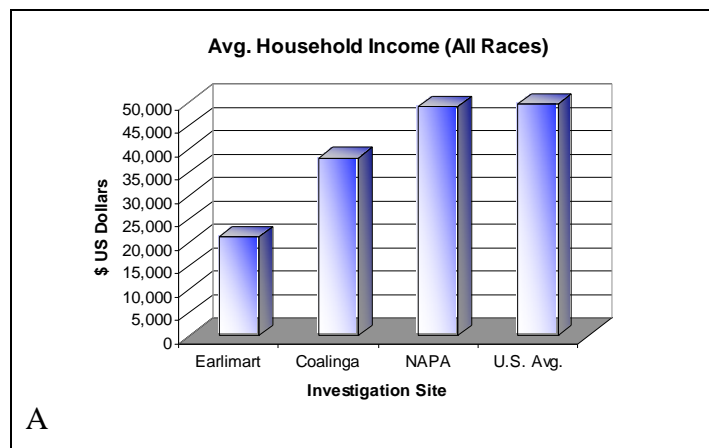
Farm-workers are faced with pesticide poisoning every day. The Central Valley, specifically the counties of Tulare, Kern, Fresno, Monterey and Kings, is where most pesticide poisoning cases occur in California.² Poisonings occur in the fields and in residential communities due to drift. Fifty-one percent of the cases from 1998 to 2000 were due to pesticide drift while twenty-five percent were due to direct skin contact, emphasizing the importance of secondary exposure.²

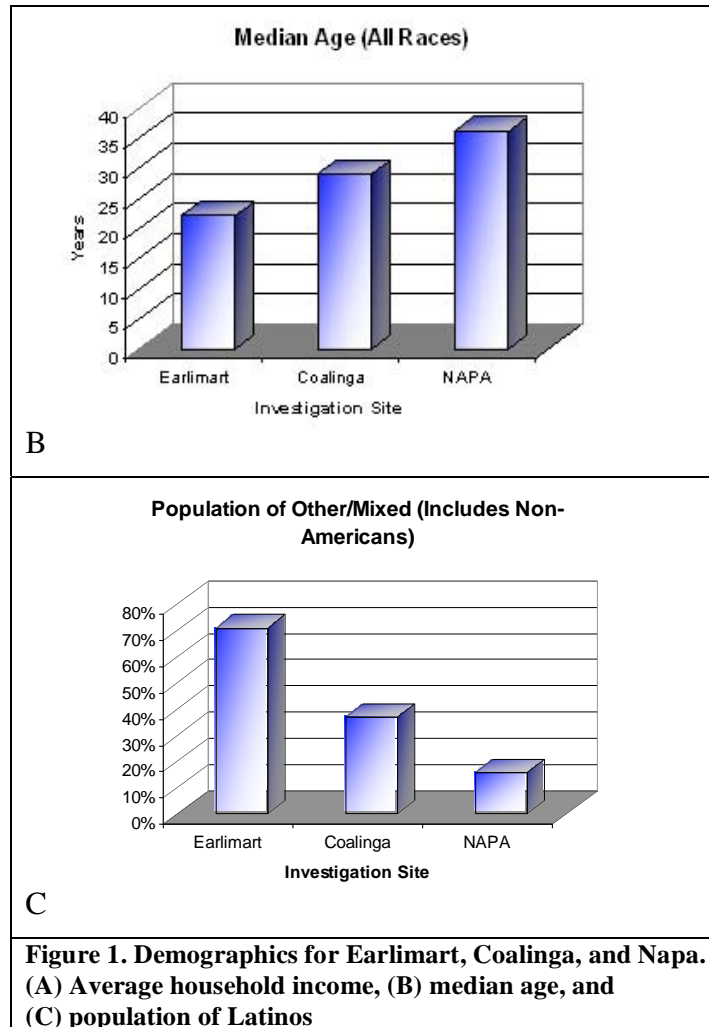
Farm-workers in the Central Valley and Napa often work picking grapes, whose vines can be saturated with pesticides. From our subsequent interviews, the workers in the Central Valley were not provided any protection; they would have to provide it for themselves. Furthermore, there is very little regulation or enforcement to protect farm-workers from pesticides. Furthermore, as mentioned previously there are large secondary effects to the communities from drift. One way in which drift occurs is through crop dusting; releasing chemicals from a low-trajectory airplane. As a result of drift, the Central Valley has the worst air quality in California. Low air quality is known to induce asthma,⁵ specifically, pesticides, such as the ubiquitous class of Organophosphates, constrict breathing, cause mucus secretion, and weaken respiratory muscles.⁶ Even low level pesticide exposure has been correlated with a 70% higher incidence of Parkinson's disease.⁷ In general, neurological diseases are common, as well as miscarriages, skin and eye rashes, and respiratory diseases.

According to the organization Californians for Pesticide Reform the California Department of Pesticide Regulation (DPR) has recorded violations among a third of the pesticide utilizing operations it oversees.² Most of these violations were due to employer negligence in making Personal Protective Equipment (PPE) available.² Only 12% of the time these PPE related violations were due to worker negligence, leaving 88% to employer negligence.²

There are many reasons why these negligence's still occur; one reason being that many of the farm-workers in the Central Valley of California are often illegal immigrants from Mexico. They work between 6 and 15 hours a day during harvest and are paid a minimum wage of \$6.75 and many times less under separate agricultural laws.⁸ The workload is highly variable, which make it difficult to support a family.⁸ Labor contractors make deals with land managers as well as farming companies, which results in farm-workers being considered cheap labor. They have very little political influence because of the language barrier and many times cannot vote and do not hold prominent positions in society.

During the course of this semester, farm-workers in three communities in the Central Valley were interviewed: Earlimart, Napa, and Coalinga. Earlimart and Coalinga are located in the southern Central Valley or the San Joaquin Valley, while Napa is located in the northern Central Valley or the Sacramento Valley. Earlimart and Coalinga are located in Tulare and Fresno counties. These counties were the sites most poisonings; between 1997 and 2000 there were 437 and 331 reported poisonings.²





In our experience with these communities we found these things to be true; we correlated these phenomena with the average household incomes, Latino populations, and average ages of each community (Figure 1).^{9,10} The average household incomes for Earlimart, Coalinga, and Napa are roughly \$19,000, \$36,000, and \$43,000, respectively. It is important to note that these are average incomes with variations. In a study done with farm-workers in Monterey county 65.9% of those interviewed were living at or below the poverty line, at \$17,050 for a family of four. 27.3% were living above the poverty line, and only 6.8% were living above twice the poverty level.¹¹

The percentage of the category “other/mixed” which includes Latinos, was 71%, 37%, and 16% for Earlimart, Coalinga, and Napa, respectively. Lastly, we observed that the communities of Earlimart and Coalinga are much younger, demographically, than Napa is. This may contribute to the income disparity between the communities. It also may point to the fact that farm-workers have low life expectancies and their work is physically demanding. The average age of each community is 22, 28.6, and 36.1 years. The demographics listed above are current as of 2007.

From the statistical data, one can see the disparities between the farming areas of Earlimart and Coalinga, and that of Napa. The cities of Coalinga and Earlimart, which are characterized by populations that are mostly Mexican-Americans, have an average household

income that is considerably lower than that of Napa, where there is a significantly lower Latino population. The average age in many of the farming communities is also fairly young, especially in Earlimart, where there is a larger population of migrant farm-workers.

Cultural and Socio-Economic Considerations

Machismo and image consciousness are aspects that we observed in the communities. These characteristics make PPE unattractive to many males and females living in these communities. It seemed as though there was image consciousness in the field, especially Earlimart, and that workers felt uncomfortable looking different from their peers. In addition, they felt pride in their work clothes and wanted to both protect themselves, but still be trendy and well-dressed. We found in our interviews that women would not be interested in suits because they did not want to appear less feminine and wanted to be more in trend.

Due to high poverty levels and low income in these communities, individuals tend to discount the value of future goods drastically. Farm-workers, first have to ration their money for necessities such as food and clothing. Therefore, they have very little disposable income to purchase a pesticide protective suit even though they are aware of the potential it holds for improving their health. Such technology is expensive and risky for them, and they do not hold the disposable income required for such a purchase. Accessories might be a cheaper and more viable option for them.

Broad Objectives

The overall objectives of this project, as outlined in the awarded NCIIA grant proposal, are to address the pesticide poisoning of the migrant farm-worker population in California's Central Valley region via two approaches: (1) mitigate pesticide exposure through the development of appropriate and effective personal protective equipment, and (2) increase awareness of pesticide poisoning through new sensor technologies and wireless acquisition of pesticide data. Since sensor technologies for this application are not currently available and are still far within the research phase, our efforts for this semester focused on improving PPE through the generation of design criteria that genuinely reflects user needs and desires. Additionally, the demand for a sustainable manufacturing institution will also be assessed.

Initial Objectives

As previously mentioned, data collected on migrant farm-workers needs and wants regarding PPE may not have been complete or authentic because these farm-workers felt disconnected from previous student groups. Because our group has two native speakers and personal connections with the migrant farm-worker community, we hope to transcend the cultural, language, or educational barriers between students and farm-workers to gather genuine data for our broad objective. Specifically, we intended to accomplish the following:

- (1) Understand the working conditions, and real and perceived routes of pesticide exposure of migrant farm-workers.
- (2) Acquire genuine feedback on the current protective suit prototype for the next design iteration.
- (3) Gauge demand for specific types of PPE, sensors, and their necessary and desirable design criteria.
- (4) Assess demand for a sustainable manufacturing cooperative for protective suit production.

Initial Approach

Background Literature Searches

To become familiar with the context of this problem, literature searches were done to gain background information on both PPE and cooperatives. Based on the emphases of the previous groups, sensor technologies and protective suit materials were researched. Comparative charts for sensor technologies can be found in Table 1 and Table 2. Sensor research was divided into two categories, academic research and commercially available products. Table 1, which is focused on technologies explored in academic research, illustrates that most new work has high sensitivity and is focused on detecting organophosphates and carbamates. While these are the target pesticide groups for this application, most of these technologies are not suitable because they require aqueous samples in order to detect pesticide contamination. This is not practical for wearable or home sensors because pesticides are present in vapor or solid phases. Although there is one gas sensing technology, it relies on gas chromatography is very expensive and requires special equipment. The common active areas of research in this field do not meet the needs of our target population, functionally or economically.

Sensing Technology	Variants	Target Pesticides	Medium	Detection Limits	Transduction	Advantages	Disadvantages
Immunoassay	Optical ^{12,13,14} (CCD imaging, fiberoptics, evanescent waves, polarization)	Imazetaphyr, atrazine, terabutylazine, 2,4-Dichlorophenoxyacetic Acid	Liquid	~ 0.X ng/ml ~ 0.0X ppb	Spectroscopy (fluorescence, infrared)	High SN ratio, high sensitivity, low cost	Limited by non-specific binding, and fluorophores
	Piezoelectric ¹⁴	Atrazine, 2,4-D, organophosphates, carbamate, parathion	Liquid	Ppb, ng/ml	Resonance	Simple principles, easy to manufacture	Difficult to model, low sensitivity, low SN
	Electrochemical ^{15,16,17} (amperometric, potentiometric, conductimetric, capacitive)	2,4-D, 2,4,5-trichlorophenoxy acetic acid, atrazine,	Liquid	~ X0 ng/ml	Current, voltage, resistance, capacitance, magnetic	Simple principles	Limited by non-specific binding, low SN
	Micromechanical ¹⁴	2,4-D	Liquid		Optical, resistance	Ultrasensitive, high resolution, easy to batch fabricate	Expensive in practice for optical systems, undeveloped
	Surface plasmon resonance ^{14,18}	Chlorpyrifos, carbamates	Liquid	Ppt	Optical	Portable, fast response time, high sensitivity, reusable	Expensive
Biosensing	Cholinesterase inhibition ^{19,20,21}	Organophosphates, carbamates	Liquid	uM	Voltage, pH, chromogenic, fluorogenic, quantum dot emission	High sensitivity	Low selectivity, significant processing, irreversibility
	Acetylcholine hydrolysis ^{22,23,24}	Organophosphates, carbamates	Liquid	uM	Voltage, current, optical, pH, capacitance	Reusable	Limited by fluorophores
Gas sensing	SnO ₂ , gas chromatography ^{21,25}	Trichlorophon, acephate gas, carbamates	Gas	Ppm	Temperature, resistivity	High sensitivity, low cost	Low selectivity, low stability, expensive, time consuming
HPLC, TLC	Post-column reactions, fluorescence ²¹	Organophosphates	Liquid	Up to atom	Spectroscopy	High sensitivity	Time consuming, expensive

Table 1. Current active areas of academic research in pesticide detection.

Commercially available technologies can be found in Table 2. Many of these products have the right form-factor and sensing mechanisms for our application, as well as desirable features including alarms and rechargeable batteries. However, most of them are unaffordable by the target population and are not specific to pesticide detection. Additionally, those that do detect pesticides do not necessary detect organophosphates. Based on the academic and commercial technologies currently available, it is clear that new technology will have to be developed for our particular application to meet both the functional and economic needs of our target population. This project has a collaborating commercial partner, Platypus, which is currently developing appropriate pesticide sensing technology.

Sensor Name	Sensing Technology	Target Pesticides	Detection Limits	Advantages	Cost	Graphic
The HazMat Smart-Strip	Reagent Detection	Chlorine, PH, Fluoride, Nerve gases, Oxidizers, arsenic, sulfides, cyanide, phosgene	Ppm	Good Form Factor, Easy to Use, High Sensitivity, multi-chemical detection	\$17.99/package	
LCD-3	Liquid Crystal Chemical Sensor	Nerve Gases, Blister/Blood Agents and Industrial Chemicals	Ppm	High Sensitivity, Good Accuracy, Easy to use	£1 million	
Aim 455 Pocket Gas Monitor	Electrochemical	Hydrogen Sulfide	Ppm	High Sensitivity, Good Accuracy, Easy to use	\$491.00	
BW Gas Alert Micro Clip Multi-Gas Monitor	Electrochemical	Carbon Dioxide, Oxygen and Hydrogen Sulfide	Ppm	Good Accuracy, Multi-Gas/Multi-Function	\$395.00	
Chemical Detection Device - Chameleon Arm band	Reagent Detection	pH Levels, Chlorine/Fluorine, Hydrogen Sulfide, Phosgene	Ppm	Portable, good in many climates and conditions	\$291.00	
Drager Safety Gas Pac 1000 Single gas Detector	Electrochemical	Hydrogen Sulfide	Ppm	High sensitivity	\$129.95	


Drager X-am 2000 EX – Alkaline Multi-Gas Monitor	Electrochemical	Hydrogen Sulfide, Oxygen and Carbon Monoxide	Ppm	Ergonomic, Water/Dust-Resistant, Vapor Sensitive, Good Sensitivity	\$480.00	
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Table 2. Current commercially available products for pesticide detection.

We also compared several chemical resistant suit materials. While these materials have many ideal qualities, they are beyond a realistic price range for most migrant farm-workers as they will have to purchase at least five suits for their weekly work. In agreement with work from previous groups, it is concluded that a protective suit made from cotton would provide the best combination of protection, cost, and environmental sustainability. Detailed charts can be found in the folder in Dr. Alice Agogino's office.

Sustainable Manufacturing Cooperative

Based on feedback on the work of previous groups, our advisor Professor Alice Agogino suggested the target communities may be interested in a sustainable manufacturing cooperative for production of the protective suits. The benefits of such an institution would be two-fold. Creating a manufacturing cooperative the communities own and run autonomously would reduce the cost of the protective suit by cutting out middlemen and also provide additional sources of income for the farm-workers. This cooperative would also empower these farm-workers by including them in the design and manufacturing of their protective suiting (demystifying technology), and have secondary effects of increasing awareness and education about pesticide poisoning. Assuming a genuine demand for a sustainable manufacturing cooperative, our group made contacts with several local cooperatives for interviews.

The Berkeley area is ideally suited for learning how to initiate, manage, and maintain cooperatives and collectives because these institutions are not only prevalent; they are also very successful and well integrated into the community. Three local cooperatives were contacted and interviewed: REI Coop, Juice Bar Collective, and the Cheeseboard Collective. Before meeting with the cooperatives, background research (Appendix) was conducted to learn more about the basic structure and philosophy behind of these institutions. This research was used to formulate interview questions that specifically addressed initiation, management, maintenance, and financial considerations for designing a successful cooperative. Table 3 shows a comparison between the three cooperatives.

Cooperative	Number of Members	Number of Stores	Hierarchy	Decision Making	Initiation
REI Coop ²⁶	>2.8 million	>90	Similar to corporations	Made by elected board member	\$15 initiation fee
Cheeseboard Collective ²⁷	12	1	None	Made by all members equally	Interviews, trial period, voting
Juice Bar Collective	6	1	None	Made by all members equally	Interviews, trial period, voting

Table 3. Comparison of REI Coop, the Cheeseboard Collective, and the Juice Bar Collective.

From the data in Table 3, it is clear that the REI Coop is closest of the three to a national corporation in terms of size, organization, and maintenance. The REI Coop has distinct hierarchy with corresponding pay scales for employees. The cooperative is run by a board of directors that are voted in by members, and membership is awarded after a financial contribution. Because of the significant financial power and organization of the REI Coop, it is not a realistic model for the proposed sustainable manufacturing cooperative.

In comparison to the REI Coop, the Cheeseboard Collective and Juice Bar Collective are more similar to one another in size, management, and philosophy. For both of these cooperatives, all employees split all aspects of the cooperatives evenly. This includes responsibilities, decision making, and profits. These qualities are specifically important for the proposed cooperative because they enable equal empowerment for all who become involved. New members are put through a vigorous screening process and unanimously voted into the cooperative, which also lowers the probability of internal conflicts. More details on the Cheeseboard and Juice Bar Collectives can be found in the Appendix. The combinations of these qualities make both the Cheeseboard Collective and Juice Bar Collective ideal models for the proposed cooperative. To better tailor these models for our proposed cooperative, feedback from the target communities would have to be gathered and incorporated into the business plan.

Field Work: Earlimart, CA

Since this project has a working collaboration with community leaders in Earlimart, CA, our group made contact with them to setup and conduct an interview session with farm-workers. Our object was to acquire specific feedback on the current protective suit prototype and the proposed sustainable manufacturing cooperative. Additionally, because previously collected data was questionable due to the disconnect farm-workers had felt with the earlier student groups, our goal also included gathering any new data that might reflect other fundamental needs and desires of this target group. To achieve these objectives, a set of interview questions (Appendix) was generated to collect data on the following topics: working conditions, pesticide concerns, current methods of protection, design criteria for the protective suit, and requirements for the sustainable manufacturing cooperative.

This interview session was designed as a two-part meeting, each 45 minutes long. The goal of the first part was to gather background and current status, while the second part was planned as a brainstorming session. This part enabled the farm-workers to show what changes they would make to their current PPE. To facilitate the brainstorming session, a prototype of the current design iteration of the protective suit, common articles of clothing, and magazines were brought as suggested items. This interview session was held at the home of one of the subjects and was informal. There were four subjects, three female and one male, and all were asked to wear their work clothing to the interview. Due to the facilities, these subjects were interviewed in either a small group (3 people) or as a single person. The coordinator and all subjects were compensated with both monetary payment and a meal.

Due to logistical issues, which will be discussed in later sections, the actual interview time was reduced to one hour. This forced both interview groups to alter the initial set of questions, and tailor them based on topics brought up in discussion. General information regarding working conditions, pesticide concerns, and current methods of protection, as well as opinions on sensors and the proposed cooperative, were fairly uniform among both interview groups. Subjects were very interested in wearing sensors and having them distributed throughout their community. All subjects showed little interest in the proposed cooperative—work and family obligations would preclude them from having time to pursue this idea. Differences in data between the two groups were found regarding the types of desired PPE and feedback on the protective suit. Subjects emphasized the importance of aesthetics as a major component for

adopting a protective suit or any PPE. All subjects showed an interest in the protective suit, but stated that other farm-workers who are less aware of the dangers presented by pesticides might not be willing to wear them due to their appearance. A more unexpected finding was that all subjects considered other PPE, such as face, eye, and hand protection to be just as, or more important than the protective suit. Results of this interview session indicated a different emphasis than the approach taken by previous groups. This variation in data suggested that further interviews should be made to determine the fundamental needs of the migrant farm-worker population.

Revised Approach

Based on our findings from the interview session in Earlimart, CA, the development of a business plan for a sustainable manufacturing cooperative was no longer an objective. All efforts were therefore put towards accomplishing the first three of our initial goals. To acquire more thorough data, a cross-comparison study was designed. Contacts were established in two other farm-worker communities: Napa, CA and Coalinga, CA. These communities were selected because of personal connections with our group members. For all interviews, demographic data could not be asked of the subjects because they are a vulnerable population.

Cross-Comparison Study: Napa, CA

To address all the new information collected from the Earlimart, CA interview session, the interview questions were modified (Appendix) for the second interview session in Napa, CA. Background questions, such as those pertaining to general working conditions, pesticide concerns, and current methods of protection were refined to achieve more specific and repeatable data. Additionally, design questions were added for face, eye, and hand PPE since these were emphasized in the interview session.

Following the two-part model initially designed for Earlimart, CA, background information and PPE brainstorming were designated as 45-minute sessions. In addition to the props brought to the previous interview session, various types of gloves, eye protection, and suits were purchased for the brainstorming section of the interview. This interview took place at the house of the coordinator, with 10 subjects (3 women and 7 men). The subjects were broken into two small mixed gender groups. Questions were answered in a discussion style and recorded as consensus rather than individual responses. The coordinator and subjects were compensated with monetary payment and a meal.

In comparison to Earlimart, CA, subjects appeared to be much wealthier and were very well aware of the dangers associated with pesticides. Based on their responses, the companies employing these farm-workers were careful about educating them and providing them with PPE for tasks involving pesticides. However, it was noted that this attention is unusual and generally only characteristic of the larger farming companies. Those who worked for the smaller farming companies had similar experiences to those described in Earlimart, CA. The majority of interviewees were interested in the sensors, protective suit, as well all other types of PPE. They also appeared more concerned with protection than appearance. These farm-workers were also interested in developing a set of workshops to help educate other farm-workers who were employed by smaller farming companies.

Cross-Comparison Study: Coalinga, CA

The last interview session was held in Coalinga, CA. This trip was organized so that our group could interview the farm-workers directly at their worksite during their lunch hour. While this would provide significant insight into their everyday working conditions, this limited the number of questions we could ask. The interview questions from the Napa, CA interview were

revised and standardized to be less open-ended and to get specific information (Appendix). This was accomplished with the help of one of Professor Alice Agogino's graduate students. Like the previous two interview sessions, background and PPE brainstorming were completed in two parts. However, this time, each session was limited to 20 minutes. All props from the previous sessions were used during the interviews.

At the interview site, farm-workers were divided into two groups: one with 6 women and the other with 5 men. These groups were divided by gender because men had dominated the mixed group discussions during the Napa, CA interview. Answers to questions were again recorded as consensus instead of individual responses. Monetary payment and a meal were used to compensate the coordinator and subjects.

When compared to the previous two interview locations, Coalinga, CA was fairly similar to Earlimart, CA in terms of economics and working conditions. All PPE worn daily was self-provided. Subjects were interested in the protective suit, sensors, and other PPE. Women were generally more content with their current protective methods than men since they usually do not handle pesticides. In addition to showing the current suit prototype and off-the-shelf PPE, two farm-workers were lent cotton coveralls similar to the suit prototype to try out in the fields. These farm-workers were initially very excited about using these suits. However, when contacted a few days later for feedback, the largest complaint was that the suits were too hot for the weather. From this initial trialability, it is clear that further trialability with future prototypes would be needed to get the most genuine feedback.

Human Subjects

As part of the broad objectives, it would be ideal to have the farm-workers themselves try out future design iterations of the protective suit and PPE that incorporate the design criteria collected from this series of interviews. Paperwork for human subjects testing, therefore, has been submitted.

Challenges and Obstacles

Like many team projects, we encountered various challenges and obstacles during the course of the semester. Our project started off with some initial problems. First, there was poor documentation and communication from past groups; therefore, we were very unclear on what efforts had been put in the past. When we did try to get in touch with past groups, we received very sparse feedback and responses. Once in touch with the past groups, we became aware of the fact that the past protective suit prototypes had been lost. Therefore, in the beginning we had very little prior information and no idea of what the initial prototypes consisted of other than from small sketches. The only information that we had about their previous findings and work was from word of mouth and one meeting with two of the previous group's members. However, there was no written record of their results or survey questions. At the mid-semester, we were able to get access to some handwritten notes of a visit the previous groups had made to some farms. Furthermore, we became aware that there was an external collaborating research group that did studies on pesticides in the Central Valley. They specifically conducted a study that examined where the entrances and threats of pesticide exposure were the greatest. However, they were not able to meet with us this semester. It was not towards the end of the semester after multiple emails that they sent us their draft findings. Therefore, initially it was challenging to gather past information from past groups.

Due to this problem with gathering information from past groups, we had discrepancies in data. Past groups stated that the community members loved the suit and were interested in a sustainable manufacturing cooperative. Therefore, we spent a couple of weeks researching cooperatives and interviewing cooperative members. However, some of the target community

members stated that they did not want the suit and felt disconnected from the previous graduate students that interviewed the farm-workers. Therefore, we were left unclear about whether or not the previous findings were genuine. Additionally, our contact in Earlimart, CA (where previous research had been conducted) stated that the farm-workers in their community would not be interested in a sustainable manufacturing cooperative. Therefore, we decided that we needed to do our own field work and research from scratch.

Once we began our own field work and research, we experienced several problems in the field. First due to experiences from past groups, our contact from Earlimart, CA had misperceptions with past Berkeley students. She showed a lack of cooperation and excitement in her contact with us. Furthermore, it was extremely difficult to schedule a meeting time with our contact to meet in Earlimart, CA with the farm-workers.

At the field site, there were communication and logistical issues. For example, we did not know children would be present—there was a clear need for babysitters that we were unaware of. Furthermore, the meal we provided as compensation was not ordered or delivered by our contact, which was our initial agreement, and thus our interview time with the farm-workers was drastically reduced. Also, the interviews occurred in an interviewee's home rather than a community center, which was not conducive to our interviewing style or procedure. We had initially long interview questions. We realized right away that we had not taken into account enough translation time. We also noticed that all the interviewees in Earlimart, CA were very aware of pesticides and its dangers. However, they still provided relevant information about the surrounding community. To avoid bias and to get a better assessment of user needs of farm-workers, we realized we needed a random sample in different, unsaturated communities. Therefore, we scheduled interviews in both Coalinga, CA and Napa, CA.

Interviews and collection of data in Coalinga, CA and Napa, CA was streamlined by our cooperative contacts. However, there were still challenges and obstacles during this process. It was challenging to design interview questions that were open-ended and unbiased, and additionally provide standardized data. Furthermore, since we were interviewing a vulnerable population, we were unable to ask any demographic data to ensure they did not feel threatened by us and would provide us with genuine and fundamental information. We also had a problem with having enough translators and recording/transcribing data as our interview samples were much larger for these communities (~10 people). By the Napa trip, we had cut down many of our questions, however our interviews were still long; therefore we spent considerable time cutting down more questions for the Coalinga trip and separating the questions that were essential to those that were optional.

After acquiring all of our data, we had challenges with analyzing and categorizing our qualitative data to extract design criteria for the protective suit, sensors, and other PPE. There were also logistical challenges for these two sites. For example, reimbursement procedures and paperwork associated with getting farm-workers compensation and coordinators paid were lengthy and complicated. Consequently, due to the long reimbursement process, our Earlimart, CA contact did not want to schedule another visit until she was paid which precluded a return visit before the end of the semester. Finally, our main advisor left on research travel, and she made an eleventh-hour assignment of a graduate student to our project in her place. This is difficult for the dynamics of our project because this graduate student was not familiar with the history or current work of the project.

Results

The interviews for this iteration of the project consisted of general background and PPE design-specific questions for the development of equipment and apparel, to help protect farm-workers from pesticide exposure. The subsequent discussion outlines our results for each design specific device along with an overview of the conditions for each site.

General Background

	Earlimart, CA	Coalinga, CA	Napa, CA
# Yrs. Working (Group Range)	8-20yrs.	3-20yrs.	3-40yrs.
Work Schedule	5-6 full days (sunrise to sunset)	5-6 days (9-12 hrs)	6-7 days (8-15hrs)
Types of Crops	Grapes	Lettuce, cotton, onions, tomatoes, pomegranates	Grapes
Tasks	Harvesting, pruning, pesticide/fertilizer spraying, planting	Cleaning ground cover, harvesting, pesticide spraying	Picking, pruning, pesticide spraying, cleaning, planting, putting up wire
Climate	Low and high temps. (Max~115°F)	Low and high temps. (Max~110-115°F)	Low and high temperatures; night shifts; work stops in extreme heat
Major Pesticide Issues	Men get sick more often than women	Children are considerably more sensitive/vulnerable than adults to pesticides	Contamination occurs when neighboring fields are sprayed
Vulnerable Body Parts	Entire face: eyes, nose, and mouth	Entire face: eyes, nose, and mouth; feet	Entire face: eyes, nose, and mouth; hands
Current PPE	Safety glasses, street clothing, handkerchiefs, hat, gloves	2-3 handkerchiefs, safety glasses, boots, long sleeve shirts, eye drops	Company provided coveralls (maintained by the company), disposable masks, boots, chemical gloves, safety glasses, street clothing, 4 handkerchiefs
Health Issues From Pesticides	Blisters, skin and eye irritation, allergies, headaches, stomachaches, nausea	Birth defects, “Valley Fever”, bumps/hives, diminished hearing abilities, soreness in legs and bones, and blood poisoning	Cancer, diabetes, birth defects, diminished vision, headaches, dizziness, skin discoloration, blisters, allergies, sterility, irritation of the eyes and respiratory tract

Table 4. General background information for the three interview sites.

For all three interview sites, as seen in Table 4, the background section of our interviews consisted of questions primarily focused on gathering information about farm-worker environmental conditions, as well as their use of PPE. These questions were intended to gather general data for each site that could be related to design-specific criteria. In this, we found that for each visited location we had mostly male workers of various ages, with work schedules that comprised a six-day work week. Though the crops in Earlimart, CA and Napa, CA consisted mostly of grapes, as opposed to those in Coalinga, CA, many of the tasks were very similar, which included planting, cultivating, harvesting and pesticide applications. Many of the people interviewed expressed concern about pesticide facial exposure with the use of PPE that provided insufficient protection, such as safety glasses, handkerchiefs, hats, and gloves. During interviews conducted in Earlimart, CA and Coalinga, CA, people spoke of the use of eye-drops as a means to mitigate the detrimental effects of pesticide exposure on their eyes. In some instances people were told to simply “cry out” the pesticides.

The farm-workers attributed many side-effects to the sprayed chemicals. Some of these side-effects at the three locations included headaches, nausea, and allergies. In Coalinga, CA, some also believed pesticide exposure was the cause of the disease caused by pesticides, “Valley Fever”, which can become quite detrimental if proper care is not provided. Finally, many people

attributed primary pesticide exposure to typical farm-work and secondary exposure through physical contact with their children (hugging) and with their vehicles after a typical day of work.

Design Criteria: Sensors

	Earlimart, CA	Coalinga, CA	Napa, CA
Desired Information from Sensors	Type and amount of pesticides in environment and on the body	Type and amount of pesticides; reagents that cause "Valley Fever"	Type and amount of pesticides
Desired Location	Homes, community, and on the torso	Entrances to community and homes, freeway, fields, and on the wrists	Freeway, fields, homes, and on the wrists
Desired Form-Factor	Wrist-watch, clock, thermostat	Large for community sensors, small for personal sensors (wrist-watch)	Large for community sensors, fire alarms/CO sizes for homes, stickers for personal sensors, wrist-watch, thermostat, clock
Desired Price	\$10	\$10-\$30	\$10-\$20

Table 5. Design criteria for sensors for the three interview sites.

Many of the farm-workers interviewed previously during the first iterations of this project informed the group that there was little warning into the severity of the pesticide environmental conditions within the fields. Currently by law, signs are to be posted to prevent people from entering fields within a certain time-frame after pesticide applications, which can be administered by plane or ground tractors. These signs might be sufficient if pesticide contamination was limited to the field. This, however, is not the case since there are many routes of pesticide contamination to other parts of communities such as through drift and secondary exposure as mentioned in the background section. With this, the group formulated questions to ascertain the desire for wearable chemical sensors as well as sensors to be placed within the fields and in homes to monitor severity levels.

As seen in Table 5, many farm workers in all three locations, expressed a desire to have sensors that could alert them into the type and amount of pesticides that they were being exposed to. Many also expressed interest in having sensors that met form-factors that could adapt to a person's wrist or mounted clock/thermostat. The desired price many were willing to pay was around \$15.

Design Criteria: Eye Protection

	Earlimart, CA	Coalinga, CA	Napa, CA
Current Eye Protection Limitations	Do not sufficiently protect from dust and pesticides	Do not adequately protect the side of the eyes from dust, no tint, foggy	Do not sufficiently protect from dust and pesticides
Desired Qualities	Doesn't trap pesticides, anti-fog, breathable, comfortable; spraying mechanism to clean out eyes	Transition lenses (not too dark), face wrapping, anti-fog	Full coverage of eyes (from pesticides and sweat), anti-fog, head strap, lightweight
Desired Price	\$15	\$10-\$25	\$15

Table 6. Design criteria for eye protection for the three interview sites.

As mentioned within the general background section, many of the people interviewed expressed much concern over the protection of their face, with emphasis on eyes and respiration exposure. Currently, many of the people that work in the fields stated that they simply use safety glasses and eye drops as a means to mitigate chemical exposure to their eyes. Recommendations for the design of eye wear included anti-fog, tint for sun protection, breathability, and isolation

from sweat and chemicals. Many also recommended that the eye protection be aesthetic pleasing, and stated specifically: “as if I were wearing sunglasses”. During the interviews, the group also presented the farm-workers with some current PPE for eyes on the market. While many of the people showed interest in the PPE, some expressed discontent, Their discontent was based that they found that suggested goggles were still foggy and penetrable by chemicals.

Design Criteria: Hand Protection

	Earlimart, CA	Coalinga, CA	Napa, CA
Current Hand Protection Limitations	Too many types of gloves, not water-resistant	Not durable, penetrable by dust, rubber gloves are too sweaty, not sufficient for cold weather	Cuffs are too short
Desired Qualities	Single glove, waterproof, thin, flexible for dexterity, low porosity, durable, scratch resistant, warm but breathable, gripping surface	Durability, larger variety of sizes to accommodate men and women	Durability, flexible, longer cuffs, breathable material for hot weather, warm material for cold weather
Desired Price	\$10-\$15	\$2-\$5	\$10

Table 7. Design criteria for hand protection for the three interview sites.

Farm-workers interviewed at the three sites had various tasks that they performed, especially the grape farmers, which required many different types of gloves to protect their hands. In Earlimart, CA and Napa, CA, many people displayed the assortment of gloves that they wore to perform various delicate and rigorous tasks. These gloves over time become costly, while still not effectively protecting them thermally and chemically. Interviewees expressed interesting a single multi-purpose glove that is waterproof, thin, durable, and dexterous. Single multi-purpose gloves tailored for the temperature extremes of the various seasons was also desirable.

During the interviews in Napa, people expressed concern over the chemical penetration through the connections made between gloves and shirts. They suggested that the gloves be made longer, or made for suit integration such as through sealed zippers to mitigate chemical penetration.

Design Criteria: Feedback regarding Protective Suit/Clothing

	Earlimart, CA	Coalinga, CA	Napa, CA
Current Clothing Limitations	Hanging straps or hooks on current protective suit prototype can be very dangerous, desirable for cold weather, but not for hot weather	Clothing is not tailored type of work; boots are too heavy; the suit is desirable for cold weather, but not for hot weather	Hanging straps or hooks can be very dangerous, suit is more desirable for cold weather, but not for hot weather
Reasons for Purchasing	Protection and comfort, some thought a protective suit is more important than gloves or eye protection, others thought the opposite	Weather and pesticide protection	Weather and pesticide protection
Desired Qualities	Light colors, elastic cuffs, extra long zippers and mesh for ventilation, non-stick material, no pull straps	Boots should be lightweight, soft (no digging into their calves), flexible, and high; lightweight suit	Full body suit, zippers along torso, multiple sizes to accommodate all body types, lighter color, sealable openings, hoods, shoe covers, attachable accessories; form fitting, stretchy, flexible material for women, stuff bag, longer leg zippers, more pockets

Desired Price	\$8-\$30	\$10-\$70	\$20-\$50
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Table 8. Design criteria for clothing and the protective suit for the three interview sites.

With regard to the pesticide protective suit, which has been iterated two times, interview questions were asked into their preferences over the current model as well as what they would prefer in a suit. During the interviews, one of the team-members tried on the suit to show its functionality and the people were then asked to give their opinion, which proved to be positive with some interviewees and negative amongst others. When the same preference questions, were asked in Coalinga, farmworkers gave more detailed design feedback as seen in Table 8. For example, they preferred a light color for high temperature work conditions, with long zippers along the pant and shirt extremities. Women in Earlimart also expressed interest in having suits made for females that were two-piece that had a tight fit, with elastic bands, for bathroom purposes. There was also interest in eliminating all straps that extended from the suit so as not to get caught in any machinery. Recommendations were also given to make the back-side of the suit equipped with cross-wind, two-layered mesh-ventilation to enhance the breathability of the suit during high-temperature climates. Overall, there was a high level of satisfaction with the current iteration of the suit and requests were made during the interviews for use. However, as mentioned in the background section, cost is still a main issue. In the end, to have the suit functional it needs to be sold/produced within their cost frame.

Design Criteria: Accessories for facial protection

	Earlimart, CA	Coalinga, CA	Napa, CA
Current Face Protection Limitations	4 handkerchiefs are too troublesome, masks are not breathable	Putting on multiple handkerchiefs is troublesome, eyes are exposed	Not completely sealed, masks are not breathable
Desired Qualities	Face mask, thicker than current handkerchiefs, breathable, covers everything above the shoulders except for the eyes	One piece face cover, various sizes to accommodate all body types	Anti-fog face shield, transition lenses, visor, suit integration
Desired Price	\$5-\$10	\$5	\$10

Table 9. Design criteria for facial protection for the three interview sites.

Many subjects during the interviews at all three sites expressed concern over the protection of their upper body, with emphasis on their eyes and respiration. Overall from the feedback, there were some recommendation for the development of anti-fog, breathable facemasks that could be made one-piece and integrated into the suit. There was also recommendation to develop respirators that could also be developed to replace the four-handkerchief arrangements that are feared to trap pesticides on the person of interest. Furthermore, they showed considerable interest in having a system where all four handkerchiefs with the cap on top could be integrated into one accessory.

Design Criteria: Suggestions to minimize secondary pesticide exposure through vehicle

	Earlimart, CA	Coalinga, CA	Napa, CA
Desired Qualities	Secondary storage for soiled clothing in the vehicle	Secondary storage for soiled clothing in the vehicle	Seat covers
Desired Price	\$8-\$30	\$15	--

Table 10. Design criteria for vehicle protection for the three interview sites.

Finally, from the interviews the group discovered that only means of protection that farm-workers instigate within their vehicles for protection from chemicals are seat covers. Many times the farm-workers leave their daily pesticide contaminated work-clothes in their vehicles, which in-turn increases the susceptibility of secondary exposure by their children who also ride in these vehicles. From the interviews, it is recommended that devices be made to contain the clothing after each day that can be placed on the suit (like the current suit-attached bags) or within the vehicles. Some of the farm-workers expressed interest in having sensors made for the cars also.

Product Search


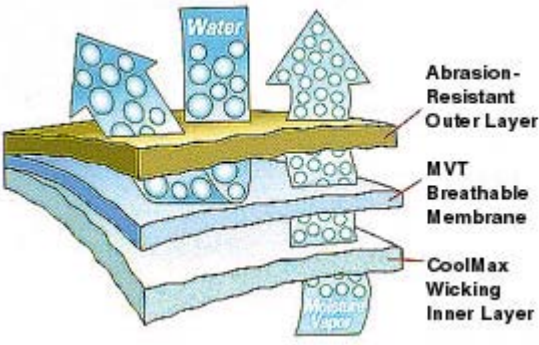
From the results of our interviews, considerations for each PPE were considered and suggestions based on industry research were performed. Considerations of materials and application-specific products were considered for each PPE.

With regard to eye protection, the group presented the farm-workers during the interviews with current-market PPE which included an assortment of goggles purchased from AirGas. Some expressed discontent with the goggles since they perceived the goggles as ineffective in mitigating chemical exposure. Others however, were very satisfied with the antifog element of the goggles. To fully understand the effectiveness of these goggles, field trainability tests with the approval of human subjects needs to be conducted. One suggestion of a goggle worth exploring are military chemical goggles, which may be effective in mitigating harsh chemicals in high-temperature climates. However, it is important to note, that mitigating the chemical exposure is more important to men, since they handle pesticides then women; emphasizing the importance of analyzing both gender preferences. As seen in Figure 2, the ESS military Advancer Goggles, with their anti-fog capability, have a patented ventilation system that can be adjusted to allow breathability and protection from outside chemicals. The materials consist of a hard plastic shell with a plastic rubber insert. They are also made aesthetic to ensure wearability. The cost for these goggles is \$83, though with further design work it is believed that this can be reduced. As mentioned, this is one option for future groups to research.



Figure 2. ESS Military Advancer Chemical Protection

With regard to hand protection, many of the farm-workers expressed interest in a multi-faceted glove that could handle many rigorous applications, while still ensuring dexterity for sensitive applications. Initially we ordered a series of gloves that are multi-faceted from AirGas and purchased some from Ace Hardware. We received feedback from their personal experience and from demonstrations of these gloves; however as with the goggles it is important that these gloves be tested in the field with approval of human subjects. One suggestion of a glove that could be tested pertaining to hand protection is the Velotique Waterproof/Breathable SealSkinz Gloves, which sell for \$50 (Figure 3). This is obviously more costly than the farmworkers can afford; however valuable feedback regarding the materials of these gloves can be obtained.

	
<p>Figure 3. Velotique Waterproof/Breathable SealSkinz</p>	<p>Figure 4. Velotique SealSkinz Gloves Composition</p>

What is important to note in the suggested glove is that the three-layer system that allows inner water vapor to escape while mitigating outside water from entering into the glove (Figure 3). One of the complaints by many of the farm-workers was the liquid water penetration on cold mornings which caused their hands to become fridged. It would be interesting to test whether the materials in these gloves can solve these problems. Again it is important to note that women and men need to be tested separately, especially since women complained of the gloves being too large for their hands, and would prefer gloves more snug and fitted to allow them to work more efficient; this is especially true for grape farmers.

Goals Validation

Minimum Goals

The first goal that the group had for this project was to complete a cross-comparison user-needs study. This goal was accomplished by conducting interviews of farm-workers in the aforementioned sites of Earlimart, CA, Napa, CA, and Coalinga, CA. We were able to get feedback from all three sites based on consistent interviews, even with our given challenges and obstacles. At each site, we were able to have an adequate number of people to generate a sufficient cross-comparison data study that covered a large part of the state of California. The large study area consisted of varying demographics and populations between cities and regions, which was able to give us rich data and outcomes that give us very good insight into the design needs of the farm-workers in California.

The second goal for our project was to improve the design of the current PPE through the development of design criteria. Since the only iterated PPE through the course of the project was the suit, we were able to gather feedback into how it could be adapted and improved to meet the needs of the people so that it will be effective and accepted by the communities. We also learned after our first interview in Earlimart of the desire to have accessories for the PPE developed, such as eye protection goggles, hand protection gloves as well as vehicle accessories to mitigate chemical pesticide exposure on and off the fields. With all of the feedback gathered we have performed preliminary industry research and have found some PPE that would be suitable for the people, and through further design, could meet their requests and needs. Before these new designs can be implemented it is important that the next groups get human subject approval to test the PPE that we purchased to fully understand what needs to be modified.

The final minimum goal for the project was the organization of past and current work. When the project began this semester, there was much disorganization with the compiled work from previous teams for this project; as mentioned in the challenges and obstacles section. With

this, there was much work that was done to ensure the thoroughness of our work to make certain of the smooth transition for the next iteration of the project. Therefore, a binder was created with all the emails and group documentation that was left with Dr. Alice Agogino for future groups.

Optimal Goals

The first optimum goal for the project was to generate new PPE and sensor designs that incorporate design criteria. Due to time constraints, although we were able to complete our interviews and generate design criteria, we still are in the process of developing designs which we plan to manufacture for field testing, which was our second optimum goal. Secondly, human subjects needs to be approved and the actual equipment tested in the field, before concrete PPE and sensor designs could be implemented. However, our interviews and research gives a solid base for future groups.

Future Directions

Upon completion of the project during this iteration, the team has set forth proposed goals that we would like to see occur in the next iterations of the project. The first proposed objective would be to develop PPE designs from our gathered interview criteria. From our industry studies, we would like to see if we can take existing technology and develop it to produce effective and economic products for farm-workers, and then perform trialability studies to see if they will be accepted. Prior to these designs, human subjects testing needs to be approved by UC Berkeley so that existing technology can be assessed and later modified with their feedback on the technology combined with our user-needs study. By doing both, future groups can be sure as to whether what the farmworkers desire is applicable in the field, and whether brand new technology needs to be developed or if an existing technology is sufficient.

Our second aspiration for the project is to introduce an educational component that will help promote and create programs for educating farm-workers and the general public into the effects and use of chemical pesticides. We would also like to see the development of a PPE infrastructure based on the development of our products with the hope and push for political mandates to ensure the people wear or are given the proper PPE. It would be ideal to have the companies pay and provide PPE. Finally, the group would also like to see a business component to the project through means of marketing strategies, to produce and distribute developed PPE within selected markets, to various communities.

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Appendix

Literature Search: Cooperatives

What is a Co-Op?

A cooperative (also known as a co-op) is a business that is owned and controlled by the people who use it. Its primary purpose is to provide goods and/or services to its members for their mutual benefit.

Why start one up?

Cooperatives were formed to gain access to goods/services otherwise not easily accessible.

- Achieving economy of size
- Increasing bargaining power
- Sharing costs of new technology
- Adding value to agricultural products
- Gaining access to new markets
- Reducing risks associated with new enterprises
- Obtaining new services
- Purchasing in bulk to achieve lower prices
- Providing credit under reasonable terms.

Many co-ops provide jobs and pay local taxes because they operate in specific geographical regions.

What are its principles?

Cooperative principles were first established in Rochdale, England in 1844, by a group of woolen mill workers who formed a cooperative to purchase household supplies in volume.

- ***Voluntary & Open Membership***
Co-operatives are voluntary organizations; open to all persons able to use their services and willing to accept the responsibilities of membership, without gender, social, racial, political or religious discrimination.
- ***Democratic Member Control***
Co-operatives are democratic organizations controlled by their members, who actively participate in setting their policies and making decisions. Men and women serving as elected representatives are accountable to the membership. In primary co-operatives members have equal voting rights (one member, one vote) and co-operatives at other levels are also organized in a democratic manner.
- ***Member Economic Participation***
Members contribute equitably to, and democratically control, the capital of their co-operative. At least part of that capital is usually the common property of the co-operative. Members usually receive limited compensation, if any, on capital subscribed as a condition of membership. Members allocate surpluses for any or all of the following purposes: developing their co-operative, possibly by setting up reserves, part of which at least would be indivisible; benefiting members in proportion to their transactions with the co-operative; and supporting other activities approved by the membership.
- ***Autonomy & Independence***
Co-operatives are autonomous, self-help organizations controlled by their members. If they enter to agreements with other organizations, including governments, or raise capital from external sources, they do so on terms that ensure democratic control by their members and maintain their co-operative autonomy.
- ***Education, Training & Information***
Co-operatives provide education and training for their members, elected representatives, managers, and employees so they can contribute effectively to the development of their co-

operatives. They inform the general public - particularly young people and opinion leaders - about the nature and benefits of co-operation.

- **Cooperation Among Cooperatives**
Co-operatives serve their members most effectively and strengthen the co-operative movement by working together through local, national, regional and international structures.
- **Concern for Community**
Co-operatives work for the sustainable development of their communities through policies approved by their members.

How are they different from businesses?

Cooperatives, start with the recognition of a need or an opportunity. Cooperatives also operate very much like other businesses. They must serve a market efficiently and effectively, they must be well managed, and they must survive financially. However, there are some **distinctions that make co-ops unique**:

- Members own their co-ops. As owners, they provide the capital necessary for start-up and growth of the business.
- Members control their co-ops. Each member usually gets one vote, regardless of the amount of equity they have invested or their use of the co-op. The board of directors is elected by the membership.
- Members benefit from their co-ops. Profits are distributed to the members based on their use of the co-op. They also have access to better prices and/or services.

Different types of Business Organizations:

Different types of business structures that exist today. *(just a summary of different ones to give them different options)*

Comparison of Business Models in the United States						
Created by Kim Zeuli, Assistant Professor, Agricultural and Applied Economics, University of Wisconsin - Madison (2003)						
				Corporations ¹		
	Proprietorship	Partnership	LLC	Subchapter S	Subchapter C (IOF)	Cooperative (Subchapter T)
Who are the owners?	Individual proprietor	General & limited partners ²	Usually 2 or more individuals, but can have one.	Minimum of 2 individuals; maximum of 75	Stockholders (general public & other businesses)	User-members (can be other businesses); minimum of 5 members in WI
How is ownership transferred?	Privately negotiated	Privately negotiated; current voting partners usually must approve new partners (depends on contractual agreement)	Privately negotiated; current members usually must approve new members (depends on bylaws)	Privately negotiated; may require corporate approval	Privately negotiated or publicly traded; if public--open to anyone with enough money to buy stock; otherwise may require board approval	Usually highly restricted; transfers to other members not typical; ownership shares usually purchased back by co-op & new members subject to board approval (depends on bylaws)
What is an individual owner's legal liability?	Unlimited	General = unlimited Limited = limited	Limited	Limited		
Who controls/ governs the business?	Owner	The partners as a whole. No board of directors; less formal	The members as a whole. No board of directors; less	Board of directors elected by a majority vote of the owners. More formal than partnership or LLC.		

			formal			
Who receives profits?	Owner	Partners in proportion to investment or agreement	members in proportion to investment or agreement	Stockholders in proportion to investment (stock)	Stockholders in proportion to investment (stock) & officers as bonus compensation	Members in proportion to their use (patronage)
Is investment limited?	Only the owner invests in the business	Anyone can invest & become a member (subject to approval)	Anyone can invest & become a member (subject to approval)	Anyone can invest (subject to approval)	Anyone can invest	Typically limited to those who use the cooperative although some non-voting shares can be sold to non-users (outside investors)
What earnings are possible on invested capital?	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Limited by law in most states; usually at 8%
Who pays income taxes?	Owner at individual rates (single taxation)	Partners at individual rates (single taxation)	Members at individual rates (single taxation)	Individuals at individual rates (single taxation)	Corporation pays at corporate rate; stockholders pay at individual rates (double taxation)	When profits are distributed to members, members pay individual rates (single taxation); cooperative only pays corporate tax on profits derived from non-member business
How difficult is it to get started?	Easy with low legal and administrative costs; very common	Easy with low legal and administrative costs; very common	Relatively easy and moderate legal and administrative costs; not as common as other organizations	More complicated and costly than partnerships or LLC; co-op requires knowledgeable legal and financial consultants which might be more difficult to find		
1. Subchapter reflects distinctions in the federal tax code 2. A limited partnership may have one or more general partners and one or more limited partners; limited partners are generally restricted from participating in management.						

What are the start-up barriers?

Need to find members, directors, etc.

Finding funding (see questions down below)

What are the different types of management/infrastructure?

A co-op is owned and controlled by the people who use its services. With customer satisfaction and meeting member needs as the principle characteristic, the interaction of the managers with the employees, or that of the board with the management is a critical issue to the success of the cooperative.

Members: Members are the reason why a cooperative is formed in the first place. Being the legal owners of the cooperative, members carry a lot of influence in the cooperative. **Members must know what the cooperative can do for them, the cooperative's purpose, mission and goals.** Members also provide the equity that is required for running a cooperative. Initially, this equity is formed by the purchase of stock/membership fees and continues by permitting the cooperative to retain a portion of the net earnings allocated to each member at the end of the year. In accordance with the cooperative principles, usually every member has one vote and the member can use that vote

- To adopt and amend articles of incorporation and bylaws.

- To elect and if, necessary, remove directors.
- To decide whether to dissolve, merge or consolidate the cooperative.
- To make sure officers, directors and other agents comply with laws applicable to the cooperative and with its articles of incorporation, bylaws and membership contracts.

Other general responsibilities include:

- Patronize the cooperative.
- Be informed about the cooperative.
- Be conscientious about when selecting and evaluating directors.
- Provide necessary capital. (*I think this where we are going to do different*)

Directors

The board of directors provides leadership and guidance to the management. Their primary responsibility is the establishment of long-term, broad objectives/purposes/visions for the cooperative. The board must hire and guide the manager. They need to ensure that operations are consistent with the articles and bylaws, understand the corporate philosophy, act in good faith in handling the affairs of the cooperative, avoid conflicts of interest, and represent the best interests of members. In addition, they also need to be able to understand and read financial statements and help in disseminating this and other relevant information to the members.

However it is important to note that individual directors should not act independently on matters that should be decided by the entire board nor should they receive special favors from the managers or employees.

We have to decide how many we need?

Managers

The general manager's principal tasks are planning, reporting to the board of directors, and maintaining good organizational relations. S/He oversees the detailed operations of the cooperative, within the policies established by the board of directors, and recommends changes and additions to the board when necessary. The manager hires, trains, supervises, and decides compensation for employees as well as reviews their performances. The manager is responsible for providing information on the cooperative (financial, operational, strategic) to the board.

How do we start one up?

Like other businesses, every co-op starts with the recognition of a need or an opportunity. One or two people willing to put in some time and energy can motivate a group interested in starting a co-op. Members of such a group have a mutual need that can be addressed through joint action. They could, for example, be faced with an uncertain market for their products or require necessary supplies or services at "reasonable prices". Acting together to address that need, they can achieve something which none of them could achieve alone.

Steps in starting a cooperative

1. Invite leading potential member-users to meet and discuss issues. Identify the economic need a cooperative might fill. *Teresa*
2. Conduct an exploratory meeting with potential member-users. If the group votes to continue, select a steering committee. *Community meeting*
3. Survey prospective members to determine the potential use of a cooperative.

4. Discuss survey results at a second general meeting of all potential members and vote on whether to proceed.
5. Conduct a needs analysis. *Our surveys*
6. Discuss results of the needs analysis at a third general meeting. Vote by secret ballot on whether to proceed.
7. Conduct a feasibility analysis and develop a business plan. (*Probably where we stop*)
8. Present results of the feasibility analysis at the fourth general meeting. If participants agree to proceed, decide whether to keep or change the steering committee members.
9. Prepare legal documents and incorporate.
10. Call a meeting of charter members and all potential members to review and adopt the proposed bylaws. Elect a board of directors.
11. Convene the first meeting of the board and elect officers. Assign responsibilities to implement the business plan
12. Conduct a membership drive
13. Acquire capital and develop a loan application package
14. Hire the manager
15. Acquire facilities
16. Begin operations

Questions for us: Critical questions

- Is there general agreement on the nature of the problem?
- Does the cooperative form of business meet the group's needs?
- Is there sufficient interest among potential co-op members to proceed with a feasibility study?
- Are there individuals willing to serve in a leadership capacity?
- Are qualified individuals conducting the feasibility study?
- Does the feasibility study indicate that the co-op would be viable as a business?
- What are the major obstacles and opportunities the co-op will face and how can the co-op prepare for them?
- Given the results of the feasibility study, is there still enough interest and commitment to pursue forming the co-op? (*we probably stop here*)
- Are there enough potential members willing to invest the required equity to provide the co-op sufficient start-up capital?
- Has the steering committee determined whether or not the co-op will issue stock?
- Has a lawyer familiar with cooperatives reviewed your co-op's articles of incorporation and bylaws?
- Has a bank account been opened in the cooperative's name?
- Will the steering committee do the business plan themselves or will the co-op obtain technical assistance? Or some of both?
- Does the steering committee have the necessary skills?
- Has the committee tried to obtain grants and loans available to help pay for technical assistance?
- Is the co-op able to obtain the necessary capital through a combination of equity and debt financing?
- Does the co-op have sufficient member support to continue?
- Is the co-op able to identify and recruit qualified individuals for key management positions?

Types of Co-ops

Co-ops are differentiated in a number of ways. One such classification is based on their function and below are the different types of co-ops under that classification.

Marketing co-ops are cooperatives formed to sell products. Initially, most were involved in marketing agricultural goods, but today this has changed to include a wide variety of products. The work that they do also varies. Some marketing co-ops limit their activity to simply negotiating prices and terms of sales with buyers. Others primarily collect similar products together and assemble them into larger quantities to

processors, wholesalers or retailers. Some examples of marketing cooperatives are Land O'Lakes, Sunkist, Blue Diamond.

Purchasing co-ops purchase supplies and goods and sell them at a reduced price to members. This reduces member costs. First used by farmers to gain access to affordable and quality supplies like feed, fertilizer etc, purchasing co-ops are now found everywhere offering a wide range of low cost goods and services. Some examples of purchasing cooperatives are ACE Hardware, Carpet One.

Service co-ops, as their name suggests, provide services. They are similar to the other co-ops discussed above in the sense that they also provide a wide variety of services and were initially formed to serve farmers. Credit Unions, Health Care providers are just some examples of service co-ops.

A **worker cooperative** is a corporation owned and controlled by the people who work in the company. A successful worker cooperative is built on each participant's strong sense of responsibility and interest in participating in company decision-making. People must commit to both invest and work in the business and to trust their co-owner/worker to be equal to the task. A high level of trust and excellent communication systems need to be developed in order to ensure success in a worker cooperative. (*we would be this one*)

Some unique characteristics of the worker owned cooperative model are:

- The workers jointly own the business. As a group they share company profits as well as risks.
- The workers/owners govern the business, typically utilizing the principle of one member, one vote to set company policies and elect board members.
- Also key is that membership is based on a joint decision to both invest in and work in the company.

References:

<http://www.uwcc.wisc.edu/>

<http://www.ica-group.org/>

<http://www.ncba.coop/>

<http://www.rurdev.usda.gov/rbs/pub/newpub.htm>

The Cheeseboard Collective and Juice Bar Collective Strategies

Initiation

- Timing
 - Societal trends, e.g. alternative living, openness, acceptance
 - Societal interest, e.g. widely acknowledged problem, common cause
- Location
 - Central to the community
 - Easily accessible
 - High traffic
 - Supportive neighborhood, similar businesses
- Personnel
 - Committed individuals with personal investment
 - Interested in the common good, cannot be greedy
- Financial
 - Self-funded (hence the personal investment)
 - Start small, be conservative

Structure

- Everyone is equal in terms of:
 - Ownership
 - Responsibilities

- Work
 - Capital, profit sharing
 - Benefits
- Simple democracy
 - Rules, by laws
 - Checks and balances
- Financial
 - No hierarchy
 - Long term planning
 - In-house facilities, little outsourcing

Maintenance

- Personnel
 - Rigorous initiation procedure
 - Interviews
 - Personality, work ethics matching
 - Probation, dedication
 - Voting of current members
- Order
 - Decision making
 - Monthly meetings
 - Voting
 - Personal disputes
 - Peer pressure
 - Peer evaluation
 - Meetings/voting
 - Member protection
 - Job rotations, avoid repetitive tasks
 - Legal initiatives, e.g. switching from small business to corporation
 - Support during disability
 - Insurance
- Reputation
 - Worker satisfaction
 - Customer service
 - Giving back to the community
 - Charity
 - Community involvement
- Financial
 - Funding
 - Private donors
 - Personal resources
 - Outside financing (slightly more difficult)
 - Operation
 - Assembly line
 - Bulk buying
 - Multi-tasking
 - Efficient, cost effective equipment
 - Customer satisfaction
 - Listening to the customer base, i.e. wants, needs, desires
 - Planning for future generations, new trends
 - Developing loyal customers
 - Incentives
 - Benefits
 - Understanding competitors and evolution of society

Earlimart, CA: Interview Questions

For Cooperative:

1. If you wanted the suits, would you be interested in making as a community, your own suits?

T. ¿Si usted quisiera los trajes, sería interesado usted a hacerlos como una comunidad, sus propios trajes?

2. Does your community have a center where you all have gatherings? (for church, functions, etc?)
If so, does it have electricity and storage space for sewing machines and supplies?

T. ¿Tiene su comunidad un centro donde ustedes tienen sus reuniones? ¿(Para la iglesia, etc)? ¿Si eso es el caso, tienen espacio para electricidad y el almacenamiento para máquinas de coser y suministros?

3. Do you sew your own garments?

If so, where do you buy their material and what type?

For Teresa: How many community members do you think have sewing machines?

T. ¿Cose usted sus propias prendas de vestir? ¿Si eso es el caso, donde compra su materia y de qué tipo?

Para Teresa: ¿Cuántos miembros de la comunidad piensa usted tienen máquinas de coser?

4. Do you have a personal computer with internet access?

For Teresa: How many people do you think have personal computers with internet access?

T. Tiene usted una computadora personal con el acceso a internet? Para Teresa: ¿Cuántas personas piensa usted tienen computadoras personales con acceso al internet?

5. Would you buy more or less of them if other community members were assembling the suits to gain extra income?

T. ¿Compraría usted más o menos trajes si otros miembros de la comunidad reunían para ensamblar para ganarse los ingresos extra?

6. Would you be interested in assembling these suits with the community?

If so, how much time could you dedicate to this?

T. ¿Sería interesado usted a ensamblar estos trajes con otros miembros de la comunidad? ¿Si eso es el caso, cuánto tiempo podría dedicar usted a esto?

7. How about self-assembly and having one community leader show everyone how to assemble the suits?

T. Que tal automontaje y tener una exposición con el líder de comunidad para que todos supieran ensamblar los trajes.

For suit:

1. What types of clothes/materials do you all typically wear when you go out to work?

T. ¿Qué tipos de ropas/materias se pone típicamente cuando usted va a trabajar?

2. Does the weather ever get very humid, or does it stay dry most of the time?

T. ¿Que tanto se pone el tiempo muy húmedo, o es que permanece seco la mayor parte del tiempo?

3. Would you all wear shorts or lighter clothing underneath pesticide protective coveralls if you had to?

T. ¿Se pusiera usted calzones o otro tipo de ropa más ligera debajo de los trajes?

4. Do you wear a particle mask or cloth around your face when you work?

T. ¿Lleva usted una máscara para proteger contra partícula o la tela alrededor de su cara cuando usted trabaja?

5. Do you find yourself bending down or standing more when you work? If you do bend down, how far do you bend (like on your knees?)

T. ¿Se encuentra usted agachándose o parándose, más cuando usted trabaja? ¿Si usted se agacha, cuán distante dobla usted (como de rodillas)?

6. When you wipe the sweat off your face, do you typically use your sleeve or do you use a rag/bandana from your pocket?

T. ¿Cuándo usted enjuga el sudor de su cara, utiliza típicamente usted la manga o utiliza usted un pañuelo de su bolsillo?

7. What colors would not want the suit to be?

T. ¿Qué colores no quisieran en el traje?

8. Do you like the prototype? Or do you think it needs a change (example-large pockets)?

T. ¿Quiere usted el prototipo? ¿O usted piensa que necesita un cambio (los bolsillos mas grandes)?

9. Where do you put your dirty clothes before washing?

T. ¿Dónde pone usted sus ropas sucias antes de lavar?

10. How often do you wash your clothes?

T. ¿Con qué frecuencia lava usted sus ropas?

11. Do you reuse your dirty work clothes?

T. ¿Vuelve a utilizar usted sus ropas sucias del trabajo?

12. When do you change your clothes after work? Before or after dinner?

T. ¿Cuándo cambia usted sus ropas después del trabajo? ¿Antes de o después de la cena?

13. What is the most important part of your body that you want protected with this suit?

T. ¿Qué es la parte más importante de su cuerpo que usted quiere que sea protegido con este traje?

14. What price do you think this suit should be sold for?

T. ¿Para qué precio piensa usted que este traje debe ser vendido?

15. How much would you realistically spend?

T. ¿Cuánto gastaría prácticamente usted?

For sensors

1. Are you worried about drift?
T. ¿Esta usted preocupado por el deriva?
2. If we could design a sensor that could detect pesticides, would you want one?
T. ¿Si podríamos diseñar un sensor que podría discernir pesticidas, quisiera usted uno?
3. If so, would you want it in your home? Your cell phone? At work? On your clothing? On your skin?
T. ¿Si eso es el caso, lo quisiera usted en su hogar? ¿En su teléfono celular? ¿En su trabajo? ¿Encima su ropa? ¿En su piel?
4. What size of sensor would make your uncomfortable? What would be your ideal?
T. ¿Qué tamaño de sensor seria incómodo? ¿Qué sería su ideal?
5. What is the most you would pay for this device?
T. ¿Cuanto seria lo maximo que usted pagaría por este sensor?

Earlimart, CA: Interview Data

	Esther and Adrienne	Kenny
Interviewee Information		
Number of Participants/Gender	1/Woman	2/Women, 1/Man
Number of Years Working	8	--
Working Conditions		
Types of Crops	Grapes	Grapes
Tasks	Picking, pruning, spraying pesticides, cleaning, planting, putting up wire	Picking, pruning, spraying pesticides, cleaning, planting, putting up wire
Work Hours/Days/Week	Sunrise-sunset/5-6 days/week	--
Weather Extremes	Low and high temperatures	High temperatures: 115 °F
Location of Eating	On the fields (ringworm infections)	--
Cleaning facilities	--	--
Childcare	--	--
Frequency of Pesticide Handling	--	Contamination occurs when neighboring fields are sprayed, spraying occurs when they are still in the fields
Pesticide Concerns		
Pesticide Perception	Very toxic, dangerous; acute and chronic problem	Harmful
Most Vulnerable Parts of the Body	Entire face (ears, mouths, noses, eyes)	Entire face (ears, mouths, noses, eyes)
Diseases from Pesticides	Problems with stomachs, eyes, respiratory tract, skin (bumps and	Blisters, skin and eye irritation, allergies, headaches, stomachaches,

	rashes), neck, hand, memory	nausea
Disease Distribution among Men and Women and Children	Men get sick more often than women	--
Routes of Exposure to Children	Clothing, car, drift	Clothing
Current Methods of Protection		
PPE	Safety glasses; street clothing, handkerchiefs, hat, gloves	Plastic gloves, masks, thick long sleeve shirts, socks, long pants
Clothing Changing Location	Bathroom, or outside during seasons of high pesticide usage (April)	Inside homes, shoes are removed in the garage and outside homes
Clothing Storage Location	Separate from children's laundry (most people do not do this); shoes are left outside	Separate from children's laundry during season when pesticides are being sprayed
Laundry Frequency	Twice a week	--
Frequency of Clothing Change	Everyday	Everyday
Routes of Exposure to Children/Protective Measures	Clothing (hugging), vehicles/ sometimes clothing is placed in the trunks, pesticide residuals in the washing machine	Clothing (hugging), vehicles, pesticide residuals in the washing machine
Company Efforts	Safety class on pesticides is provided; "blue card" required by companies to work; not everyone takes this class	Instructional classes on equipment use and methods of pesticide protection; however, very little PPE is provided; suits have been provided to those who spray pesticides
Sensors		
Current Technology	--	--
Information Desired from Sensors	Type and amount of pesticide in the environment; location of pesticide exposure on the body	Type and amount of pesticide
Desired Locations	Community, on the body	Homes, on the chest
Desired Form-factor	--	Wrist-watch size, clock, thermostat
Reasonable Price	\$10 (\$20 is expensive)	\$10
Eye Protection		
Current Eye Protection	Safety glasses; eye drops	Safety glasses; eye drops
Problems	See "Face Protection"	Do not sufficiently protect from dust and pesticides
Desired Qualities	Doesn't trap pesticides, anti-fog, breathable, comfortable; spraying mechanism to clean out eyes	--
Current Price	--	--
Reasonable Price	--	\$15
Hand Protection		
Current Hand Protection	Multiple gloves for each task	Two main gloves
Problems	Too many types of gloves	Not water resistant (leather and cotton gloves)
Desired Qualities	Single glove, waterproof, thin, flexible for dexterity, low porosity, durable, scratch-resistant, warm but breathable, gripping surface, many colors and sizes for different tastes	Waterproof, warm
Current Price	\$1-\$10	--

Reasonable Price	\$10-\$15	\$10/pair
Clothing		
Current Clothing	Turtlenecks, jeans, long sleeve shirts, button-up shirts, sweater/jackets for weather	Women: tight jeans, long sleeve shirts; Men: jeans, boots, long sleeve shirts, undershirts
Problems	Pesticide protective suit prototype: hanging straps or hooks can be very dangerous	Pesticide protective suit prototype: desirable for cold weather, but not for hot weather
Reasons for Purchasing	Protection and comfort, other people are most interested in aesthetics	Protection, a suit is more important than gloves or eye protection
Desired Qualities	Pesticide protective suit prototype: people are not interested; Pants: jeans, fashionable, comfortable, breathable, dirt resistant; Shirts: turtlenecks, button-up shirts, multiple colors for matching, comfortable and breathable	Company provided coveralls, shoes, and gloves; stuff bag; leather, long sleeves, two pieces, many pockets, form fitting, neck protection, pocket for eyewear, water-resistant, thick material; boots; elastic at the wrists and ankles, zippers
Current Price	--	--
Reasonable Price	Pants: \$20-30; Shirts: \$10-\$15	Suit: \$8, \$10-\$15
Face Protection		
Current Face Protection	Hat, 4 handkerchiefs; men wear 1 handkerchief for sun protection only, masks worn when high levels of pesticides are being sprayed (April)	Hat, 5 handkerchiefs, hood
Problems	4 handkerchiefs are too troublesome	Masks: low breathability
Desired Qualities	Covers everything above the shoulders except for the eyes	Face mask, thicker than current handkerchiefs, breathable
Current Price	--	--
Reasonable Price	Mask: \$5-\$10; Hat: \$5	--
Vehicle		
Current Vehicle Protection	None	--
Desired Qualities	Secondary containment for clothing	--
Reasonable Price	--	--
General		
Sustainable Manufacturing Cooperative	Too much work, not enough time	Not interested because not enough time
Concerns	--	Pesticide drift, barriers between the homes and fields such as trees

Napa, CA: Interview Questions

Fundamental Needs Assessment

- 1.) Interviewee Information
 - a. How long have you been working in this area/at this job?
- 2.) Working Conditions
 - a. What kind of work do you do? What tasks are involved?
 - b. How many days a week do you work? How long are your work days?
 - c. What are the general weather conditions?

- d. Where do you eat your meals at work? Do you wash your hands or change your clothing before eating?
- e. Who provides childcare for your children while you are at work?
- f. Are there any environmental challenges that affect your work, e.g. frost, smog, etc.?
- g. How often do you use pesticides?

3.) Pesticide Concerns

- a. Do you think that pesticides are harmful? Why or why not?
- b. What areas of your body are most vulnerable to pesticides (route of exposure)?
- c. In your opinion, what are the biggest causes of sickness in your community?
- d. Are people in this area getting sick because of pesticide exposure? What percent?
- e. What type of diseases are people getting from pesticide exposure? Are these different for men and women?
- f. Do men or women get sick more often? Why do you think this is?
- g. Do you think your children are affected by pesticides? Do they get sicker at different times of the year?

4.) Current Methods of Protection

- a. Do people have methods of protecting themselves from pesticides, and do most people adopt these methods?
- b. What do most people do to protect themselves from pesticides?
- c. What kind of clothing do you wear on the field? How do you deal with daily variations in the weather?
- d. Where do you change your clothing when you come home from work?
- e. Where do you store your clothing and shoes after you come home from work?
- f. Do you have new sets of clothing for each day of work?
- g. Do these methods vary for men and women? Why?
- h. Do you think these methods provide sufficient protection? Why or why not?
- i. Do you think that you are a route of pesticide exposure to your children?
- j. Do you take any precautions to protect your children from pesticides?
- k. How do people launder their field clothing, i.e. clothing exposed to pesticides? How often is laundry done?
- l. Are you concerned with pesticide contamination of your car? Do most people have methods of reducing this contamination?
- m. Does your employer have any methods of educating or protecting you from pesticides?
- n. Does your employer provide any safety classes on pesticide protection? If so, how many people take this class?
- o. Does your employer provide you with PPE?

PPE and Brainstorming

1.) Brainstorming

- a. If you had all the resources in the world, how would you protect yourself and your family from pesticide exposure?
- b. What technologies are you interested in, e.g. sensors, PPE, etc?

2.) Sensors

- a. What information would you like a sensor to tell you about pesticides?
- b. Would you like sensors to be community or individually based?
- c. If you want sensors in your community, where would you like them to be located?
- d. If you want sensors to be individually based, where would you like them to be located?
- e. Are you interested in wearing sensors or having them in your home?
- f. What is a reasonable cost of a sensor? What do you consider expensive?
- g. Do you have a size/appearance preference for a sensor? Do these preferences depend on the type of sensor (community or individually based)?

3.) Eye Protection

- a. What are the problems with your current eye protection? How often do you wear it?
- b. How do you maintain your current eye protection? How do you store it?
- c. Do you use eye protection for other purposes besides protection from pesticides?
- d. If the current eye protection is not adequate, what are the consequences?
- e. Do these consequences prevent you from wearing your eye protection?
- f. How do you deal with these consequences?
- g. How much do you currently pay for eye protection?
- h. What qualities do you look for in eye protection? What aspects would make eye protection undesirable?
- i. What changes would you make to your current eye protection to improve it?
- j. Are there certain aesthetic characteristics that would make you more or less interested in wearing eye protection?
- k. If there was an eye protection product that met all of your requirements, what would be a reasonable price for it? What would be too expensive?

4.) Hand Protection

- a. What are the problems with your current hand protection? How often do you wear it?
- b. How do you maintain your current hand protection? How do you store it?
- c. What do you currently pay for your hand protection?
- d. What qualities do you look for in your hand protection?
- e. What changes would you make to your current hand protection to improve it?
- f. Are there gender specific problems with the current hand protection?
- g. Do you wear your hand protection for environmental or work reasons, or both?
- h. Are there aesthetic characteristics that would make you more or less interested in wearing hand protection?
- i. If there was a hand protection product that met all of your requirements, what would be a reasonable price for it? What would be too expensive?

5.) Clothing: Upper and Lower Body

- a. What do you currently wear?
- b. How often do you wear this clothing before you wash it?
- c. How do you maintain and store your clothing after work?
- d. What are the problems with your current clothing?
- e. Do you feel that your current clothing adequately protects you?
- f. What characteristics are you looking for when you purchase clothing?
- g. What areas of your body are you trying to protect?
- h. Are you more concerned with pesticide protection or appearance when you choose this clothing?
- i. What types of materials are you interested in wearing?
- j. Does this clothing change from season to season?
- k. What characteristics would make a piece of clothing undesirable to wear?
- l. Are there gender specific requirements, either for aesthetics or for protection?
- m. How important is the appearance of your clothing?
- n. What designs and colors are popular?
- o. What do you currently pay for your clothing?
- p. Are there improvements that can be made to this clothing that would protect you from pesticides better?
- q. What would you pay for clothing that met both your aesthetic and protection needs?

6.) Face and Head Protection

- a. What do you currently wear? Why?
- b. How do you deal with sweat during the day? How do you avoid contaminating your face/head?
- c. Where do you store the item you use to wipe away sweat?
- d. How often do you wear these items before you wash them?

- e. How do you maintain and store these items after work?
- f. Are there problems/limitations associated with these protective items?
- g. What changes would you make to improve them?
- h. Do you think these items adequately protect you?
- i. Do these protective items vary for men and women? Why is this the case?
- j. What designs and colors are popular for these items?
- k. Do you use these items for reasons other than pesticide protection?
- l. What do you current pay for these items?
- m. What materials do you look for when you purchases these items? What characteristics make them desirable?
- n. If there were protective items that met all of your requirements, what would be a reasonable price for them?

7.) Vehicle

- a. What type of technology would you use to prevent contamination of your vehicle with pesticides?
- b. Are your current methods of protection adequate? Why or why not?
- c. What would you do to improve these methods? Why would those suggestions be improvements?
- d. Are you interested in using a secondary containment that could be easily stored away?
- e. Do you clean your vehicle to reduce pesticide contamination?
- f. What would you pay to protect your vehicle from contamination?

8.) General

- a. Are there any issues we have not covered?
- b. Are they any suggestions you have for us?
- c. Are there other issues in your community related to pesticides that we have not addressed?
- d. What are your expectations of us and future groups of students who work on this project?

Napa, CA: Interview Data

	Esther and Adrienne	Kenny
Interviewee Information		
Number of Participants/Gender	4/Men; 1/Woman	3/Men; 2/Women
Number of Years Working	20, 26, 30	3, 33, 36, 40
Working Conditions		
Types of Crops	Grapes	Grapes
Tasks	Picking, pruning, spraying pesticides, cleaning, planting, putting up wire	Picking, pruning, spraying pesticides, cleaning, planting, putting up wire
Work Hours/Days/Week	8-12 hours/5-6 days/week	8-15 hours/6-7 days/week
Weather Extremes	Low and high temperatures; sometimes night shifts; work stops in extreme heat	Rain, low and high temperatures; work stops in extreme heat
Location of Eating	In personal cars; clothing is not changed before eating	Side of the field; hands are not always washed (depends on the location of the bathrooms)
Cleaning facilities	Bathrooms with soap, water, towels	Bathrooms
Childcare	Trustworthy neighbors, paid out of personal income	Friends

Frequency of Pesticide Handling	Once per month for 4 months, men usually handle pesticides	Sometimes; contamination occurs when neighboring fields are sprayed
Pesticide Concerns		
Pesticide Perception	Very toxic, dangerous	Harmful
Most Vulnerable Parts of the Body	Entire face (ears, mouths, noses, eyes)	Entire face (ears, mouths, noses, eyes); hands
Diseases from Pesticides	Cancer, asthma, allergies, pain in the eyes and nose	Cancer, diabetes, birth defects, diminished vision, headaches, dizziness, skin discoloration, blisters, allergies, sterility, irritation of the eyes and respiratory tract
Disease Distribution among Men and Women and Children	Equal	--
Routes of Exposure to Children	Clothing, drift	--
Current Methods of Protection		
PPE	Company provided coveralls (maintained by the company), disposable masks, boots, chemical gloves, safety glasses, street clothing, 4 handkerchiefs	Plastic gloves, masks, thick long sleeve shirts, socks, long pants
Clothing Changing Location	Bathroom, garage	Home, shoes are removed in the garage and outside homes
Clothing Storage Location	Separate from children's laundry; shoes and sometimes clothing are left outside	Separate from children's laundry during season when pesticides are being sprayed
Frequency of Clothing Change	Generally everyday, can be up to 2 days	Everyday
Routes of Exposure to Children/Protective Measures	Clothing (hugging), vehicles (sometimes clothing is placed in the trunks), pesticide residuals in the washing machine	Clothing (hugging), vehicles, pesticide residuals in the washing machine
Company Efforts	Annual workshop for educating workers about the dangers of pesticides; company provides videos, books, presentations, and speakers; PPE is provided	Instructional classes on equipment use and methods of pesticide protection; however, very little PPE is provided; suits have been provided to those who spray pesticides
Sensors		
Current Technology	Paper sensors located at each block	--
Information Desired from Sensors	Type and amount of pesticide	Type and amount of pesticide
Desired Locations	Community, homes (outside entrances and in living rooms)	Freeway, fields, homes, wrist
Desired Form-factor	Large for community sensors, fire alarm/ CO detector sizes for homes, stickers for personal sensors	Wrist-watch size, clock, thermostat
Reasonable Price	\$20 (home and skin), \$10 (clothing)	\$20
Eye Protection		
Current Eye Protection	Safety glasses	Safety glasses
Problems	See "Face Protection"	Do not sufficiently protect from dust and pesticides
Desired Qualities	See "Face Protection"	Full coverage of eyes (from

		pesticides and sweat), anti-fog, head strap, lightweight
Current Price	--	--
Reasonable Price	--	\$15
Hand Protection		
Current Hand Protection	Company provided gloves	Company provided gloves
Problems	Cuffs are too short	--
Desired Qualities	Long cuffs; attachable and interchangeable with the suit, task specific (e.g. fingerless for tying), thick for pesticide protection, water-resistant	Durability, flexible, longer cuffs (3/4 sleeve), breathable material for hot weather, warm material for cold weather
Current Price	Company provided	--
Reasonable Price	--	\$10/pair
Clothing		
Problems	Pesticide protective suit prototype: hanging straps or hooks can be very dangerous	Pesticide protective suit prototype: desirable for cold weather, but not for hot weather
Reasons for Purchasing	Protection and comfort	Protection, a suit is more important than gloves or eye protection
Desired Qualities	Pesticide protective suit prototype: full body suit, zippers along torso, multiple sizes to accommodate all body types, lighter color, sealable openings, hoods, shoe covers, attachable and interchangeable accessories; form-fitting, stretchy, flexible material for women	Stuff bag; pesticide protective suit prototype thickness, fit, and color are suitable; hood, longer leg zippers, more pockets
Current Price	People believe companies should provide this PPE	--
Reasonable Price	\$50	Suit: \$20
Face Protection		
Current Face Protection	Hat, 2-3 handkerchiefs, face masks	Hat, towels
Problems	Not completely sealed	Masks: low breathability
Desired Qualities	Anti-fog face shield, transition lenses, visor, suit integration	Anti-fog, head strap, isolates the eyes from sweat and pesticides
Current Price	--	Hats: \$10/3
Reasonable Price	--	\$5
Vehicle		
Current Vehicle Protection	None	--
Desired Qualities	Seat covers, multiple cars	--
Reasonable Price	--	--
General		
PPE	--	--
Concerns	Education program: seminars/speakers, small groups, visitation of other farms	--

Coalinga, CA: Interview Questions

Fundamental Needs Assessment

5.) Interviewee Information

- a. How long have you been working in this area/at this job?

6.) Working Conditions

- a. What kind of crops do you work with? Name the tasks you do.
- b. Do you work more than 5 days a week? Do you work more than 8 hours a day?
- c. What are the daily and yearly weather extremes?
- d. Do you handle pesticides? If so, how often?

7.) Pesticide Concerns

- a. On a scale of 1-5 (1 = not concerned at all, 5 = extremely concerned), how concerned are you with the dangers of pesticides?
- b. What areas of your body are most vulnerable to pesticides?
- c. What percentage of people in this area gets sick from pesticide exposure? Are these different for men, women, and children?
- d. *Do you think children are more vulnerable to the dangers of pesticides than adults?*

8.) Current Methods of Protection

- a. What do most people do to protect themselves and family from pesticides (i.e. eyes, hands, body, face, and vehicle)? Are these methods different for men and women?
- b. Where do you change/store your clothing at home after work?
- c. Do you think that you are a route of pesticide exposure to your children?
- d. Are you concerned with pesticide contamination of your car?
- e. Does your employer provide you with pesticide education or protective equipment?

PPE and Brainstorming

9.) Sensors

- a. What information would you like a sensor to tell you about pesticides?
- b. Would rather have community or individual sensors?
- c. If you want community sensors, where would you like them to be located?
- d. If you want individual sensors, where would you like them to be located?
- e. What is a reasonable cost of a sensor?
- f. Do you have a size/appearance preference for a sensor?

10.) Eye Protection

- a. What are the limitations of your current eye protection and what would you change to improve it?
- b. *Does your eye protection double as sunglasses?*
- c. *How much do you currently pay for eye protection?*
- d. Are there aesthetic characteristics that would make you more interested in wearing eye protection? Colors? Fit? Materials? Design?
- e. If there was an eye protection product that met all of your requirements, what would be a reasonable price for it?

11.) Hand Protection

- a. What are the limitations of your current hand protection and what would you change to improve it?
- b. *Do you use your hand protection to keep warm in cold weather?*
- c. *What do you currently pay for your hand protection?*
- d. Are there aesthetic characteristics that would make you more interested in wearing hand protection? Colors? Fit? Materials? Design?

- e. If there was a hand protection product that met all of your requirements, what would be a reasonable price for it?

12.) Clothing: Upper and Lower Body

- a. How often do you launder your work clothing? Do you wash your work clothing separately from non-work clothing?
- b. What are the limitations of your current work clothing and what would you change to improve it?
- c. *Is appearance or pesticide protection more important to you when purchasing clothing?*
- d. Are there gender specific requirements, either for aesthetics or for protection? Colors? Fit? Materials? Design?
- e. *What do you currently pay for your clothing?*
- f. What would you pay for clothing that met both your aesthetic and protection needs?

13.) Face and Head Protection

- a. What are the limitations of your current face and head protection and what would you change to improve them?
- b. *Do you use these items for sun protection? How do you deal with sweat?*
- c. Do these protective items vary for men and women?
- d. *What do you currently pay for these items?*
- e. If there were protective items that met all of your requirements, what would be a reasonable price for them?

14.) Vehicle

- a. What are the limitations of your current methods for preventing vehicle contamination, and what would you do to improve these methods?
- b. What do you/would you pay to protect your vehicle from contamination?

15.) General

- a. Are there any suggestions you have for us?
- b. Are there other issues in your community related to pesticides that we have not addressed?

Coalinga, CA: Interview Data

	Esther and Adrienne	Kenny
Interviewee Information		
Number of Participants/Gender	6/Women	5/Men
Number of Years Working	3, 4, 6	5, 10, 15, 20
Working Conditions		
Types of Crops	Lettuce, cotton, onions, tomatoes, pomegranates	Tomatoes, cotton, lettuce, grapes, almonds
Task	Cleaning ground cover, harvesting	Pesticide spraying
Work Hours/Days/Week	9.5 hours/6 days/week	9-12 hours/5-6 days/week
Weather Extremes	105-110 °F	Rain, high temperatures
Frequency of Pesticide Handling	Rarely; generally handled by men	Sometimes
Pesticide Concerns		
Rating of Concern	5	2, 5 (depends on the pesticide being sprayed)
Most Vulnerable Parts of the Body	Face (eyes and noses)	Eyes, noses, mouths
Diseases from Pesticides	Birth defects, "Valley Fever",	Watery eyes, blisters

	bumps/hives, diminished hearing abilities, soreness in legs and bones, and blood poisoning	
Disease Distribution among Men and Women	Equal	Equal
Sensitivity of Children	Higher vulnerability than adults	Higher vulnerability than adults
Current Methods of Protection		
PPE	2-3 handkerchiefs, safety glasses, men wear dust masks occasionally	Boots, long sleeve shirts, eye drops
Clothing Changing Location	Backyard, garage	--
Routes of Exposure to Children/Protective Measures	Clothing (hugging), vehicles	Clothing, vehicles (dust off clothing before getting into vehicles)
Company Efforts	Required safety course on pesticides	Required safety course on pesticides (30-40 minutes); validated by card (good for 5 years); videos are given once a year
Sensors		
Current Technology	--	Signs at the fields that give wait times before entering is safe
Information Desired from Sensors	Type and amount of pesticide; reagents that cause "Valley Fever"	Type and amount of pesticide
Desired Locations	Entrances to community and homes	Freeway, fields, homes, wrist
Desired Form-factor	Large for community sensors, small for personal sensors	Wrist-watch size
Reasonable Price	\$20, \$25, \$30 (home and skin), \$10 (clothing)	\$10, \$15, \$20
Eye Protection		
Current Eye Protection	Safety glasses (rarely worn, 50% of people do not even own them)	--
Problems	Do not adequately protect the side of the eyes from dust, no tint, foggy	Foggy, not aesthetically pleasing
Desired Qualities	Transition lenses (not too dark), face wrapping, anti-fog	Anti-fog, small, very transparent
Current Price	\$5	\$5
Reasonable Price	\$20, \$25	\$10
Hand Protection		
Current Hand Protection	Gloves	Cotton gloves
Problems	Wear out quickly, generally last 1 week, 2-3 weeks with washing	Penetrable by dust; rubber gloves are too sweaty; not sufficient for cold weather; two pairs/week
Desired Qualities	Durability	Durability, larger variety of sizes
Current Price	\$1.99/pair or \$5/12 pairs	\$2.50/pair
Reasonable Price	\$2-\$5/pair	--
Clothing		
Laundering/Frequency	Work clothing is washed separately with soap and color-safe bleach/laundry is done every week	Work clothing is washed separately; generally followed by older men and women
Problems	Clothing is not tailored to their line of work; boots are too heavy	None; Pesticide protective suit prototype is desirable for cold weather, but not for hot weather
Reasons for Purchasing	Weather protection	Protection

Desired Qualities	Boots should be lightweight, soft (no digging into their calves), flexible, high	Lightweight
Current Price	Boots: \$15, \$35, \$50	Shirts: \$10/3, \$5/2
Reasonable Price	Boots: \$20, \$50, \$70	Suit: \$15
Face Protection		
Current Face Protection	Hat, 2-3 handkerchiefs (sweat is not a big issue)	Hat, 1 handkerchief (sun protection and sweat)
Problems	Hats fly off easily, putting on multiple handkerchiefs is troublesome	Exposed eyes
Desired Qualities	One-piece face cover	Various sizes to accommodate all body types
Current Price	Handkerchiefs: \$1 for small, up to \$12 for large	Hats: \$10/3
Reasonable Price	\$20, some people do not think this is an issue at all (would not buy)	\$5
Vehicle		
Current Vehicle Protection	None	Seat covers
Desired Qualities	Pop-up storage for soiled clothing in the vehicle	--
Reasonable Price	--	\$15
General		
PPE	--	Interested in face masks
Concerns	Pesticide drift	Contaminating children